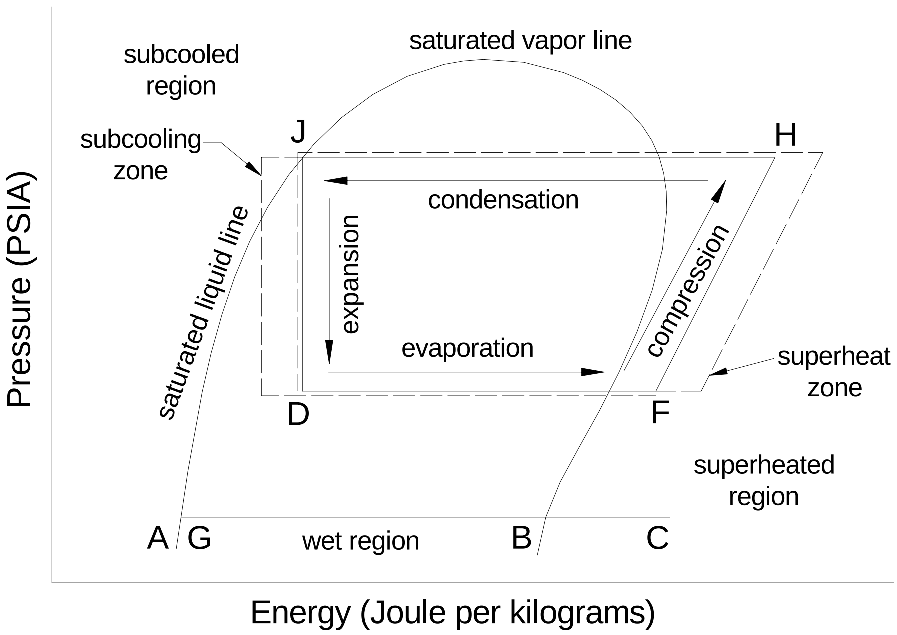
-HOW A WATER CHILLER WORKS-

Mechanical water chiller is used to remove heat from a colder medium and reject it to a warmer medium by using the latent heat properties of the refrigerant. Simply stated, in order to accomplish this transfer of heat energy, the refrigeration system must provide a refrigerant temperature below the temperature of the medium to be cooled and raise the temperature of the refrigerant to a level above the temperature of the medium that is used for rejection. Although the entire chiller package is more complex, the basic components required for mechanical refrigeration are the compressor, evaporator, condenser and thermostatic expansion valve. A complete typical chiller layout follows this section.



The P-E chart is an important tool in understanding the property changes that take place during each phase of the cycle and provides a graphical means of study. Horizontal lines on the P-E chart are lines of constant pressure and vertical lines are lines of constant enthalpy or heat energy.
The lines labeled “Saturated liquid line” and “Saturated Vapor Line” are plots of the pressure-vs-energy for the saturated state of a given refrigerant. The chart is divided into three regions. The area to the left is the subcooled region, to the right is the superheated region and in the middle is the wet region or mixture state. The constant temperature lines are horizontal in the mixture region indicating that phase change occurs at constant pressure. Likewise, expansion of the gas takes place at constant energy.

Following the chart, if refrigerant liquid at point A absorbs heat at constant pressure, it will begin to boil. Evaporation takes place with no change in temperature. As heat is added, the energy increases and it enters a mixture state of vapor and liquid. At point B, the mixture becomes a saturated vapor. Any additional heat applied at constant pressure causes the refrigerant to enter the superheat region indicated by point C.

In evaporation, the refrigerant enters the evaporator as a mixture of vapor and liquid at point D of the chart. It enters the evaporator by being metered through a thermostatic expansion valve which lowers its pressure and therefore its temperature. Because the refrigerant is at a temperature below the process fluid, it absorbs heat from the process fluid, boils and change phase from a liquid to a gas. In order for the refrigerant to change state, it must take in heat energy.

During this transfer of heat energy, only latent heat is absorbed resulting in the refrigerant remaining at a constant temperature. In theory, it leaves the evaporator as a vapor at point E, however, in application, additional heat, called “superheat” is added to prevent liquid condensation in the lines that can damage the compressor. After absorbing the latent heat during evaporation and superheating, the refrigerant gas is compressed from a low pressure gas to a high pressure gas. The additional heat energy caused by compression is represented by the line between points F and H. Note that point H is to the right of point F, indicating the additional energy resulting from the Heat of Compression. The now hot, high pressure gas is passed through a condenser to remove the heat of compression plus the latent heat of evaporation. This heat is typically rejected to ambient air in an air cooled condenser package. From the P-E chart, it can be seen that condensation takes place at constant pressure.

The heat transfer is represented by the difference in energy between points H and J. At point J the refrigerant is totally condensed into a liquid and remains at constant pressure. Superheat is the heat added to the vapor beyond what is required to vaporize all of the liquid. Superheat therefore is not latent, but sensible heat and is measured in degrees. From the chart below, it can be seen that superheat from the evaporation phase has a corresponding increase in the total heat of rejection at the condenser and results in the compressor operating at higher temperature. While some amount of superheat is required to protect the refrigeration system and prevent liquid entering the compressor, too much superheat can contribute to oil breakdown and increased system downtime.

Subcooling is the process of cooling condensed gas beyond what is required for the condensation process. Subcooling is sensible heat and is measured in degrees. Subcooling can have a dramatic effect in the capacity of a refrigeration system by increasing the capacity of the refrigerant to absorb heat during the evaporation phase for the same compressor Kw input.

Subcooling assures that no gas is left at the end of the condensing phase, thus assuring maximum capacity at the thermostatic expansion valve.

We are sure this explanation will give you a clearer picture on water chillers as a reliable solution to provide constant cooling conditions for many types of instruments.